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(54) **Locating portable devices**

(57) A lost telephone or other portable device with a long-range transceiver and also a RF or other short-range scanning device is located with the aid of a second such device that has a matching tag. A server instructs 203 the lost device to scan 204 for a second device: when a second device is found a message is set to the user of the second device. If no second device can be found, the server may contact potential second devices directly and instruct them to scan for the lost device (this requiring that the lost device has a tag and the potential second devices have scanners). In either case the lost device is triggered to give audible warning for the user of the second device. In the event that this is not possible because the lost device is switched off, a third *modus operandi* provides that the second device can send a power-on signal via the lost device's tag circuits.

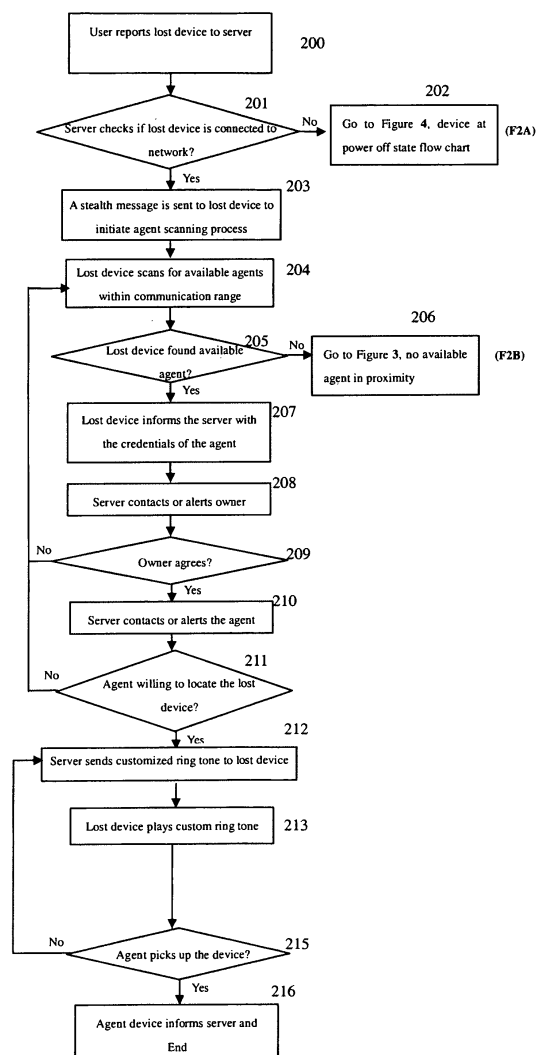


Figure 2

Description

[0001] Due to the increasing usage of personal mobile gadgets such as laptops, Personal Digital Assistants (PDA), and cellphones, numerous methods have been developed to track these devices. Current tracking technologies for most of the mobile handheld devices focus on a software-based approach. Tracking software is installed on the mobile handheld device's memory. On the other hand the tracking of mobile devices using Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) requires the use of the device's number, the handset's International Mobile Equipment Identity (IMEI) number or the Subscriber Identity Module (SIM) card's International Mobile Subscriber Identity (IMSI) in order to identify the lost device. The tracking systems described above require the mobile devices to be power on and connected to their respective network in order for the tracking mechanism to take place. Furthermore, GSM can only offer limited accuracy in term of location. It is therefore difficult to locate an individual device especially when there are a large number of other mobile devices in the vicinity.

[0002] Radio Frequency Identification (RFID) has become popular as its range has increased significantly over the years. Passive RFID tags can be read from a distance of about 3 to 6 feet. RFID has been proposed by many for product tracking and monitoring, lost pet notification, and lost article tracking. Such systems are separately described in various patents such as US Patent 5570081, US Patent 6067018, US Patent 6940407, European Patent 1630757 and Japan Patent 2006092128. Although such systems provide a useful mechanism to track the lost or stolen item at close proximity through the use of static or mobile RFID readers, these systems do not provide precise location indication in identifying the particular lost article which is important to small size articles such as mobile handheld electronic equipment. Auxiliary means such as providing the lost item's pictures to the third party human agent in order to identify the lost article are typically deployed. Foreseeing that the RFID tag and reader will become more common in future mobile handheld devices such as mobile phones, various methods involving the exchange of information with a server through the mobile network to compare the targeted lost device's attributes with those recorded in the server in order for third party human agent to exactly identify the respective article have been proposed. However, such systems do not provide sufficient privacy and security measures as the lost device's information is broadcast to a large crowd of human agents in the proximity. Existing methods also risk a large crowd of users going after the same lost device. In addition, the risk of disclosing device's information to unwanted third parties is high as the lost device has no control in determining the respective third party. Thus there is a need in the art for a secured system that can precisely indicate its location once the lost item is being located by third party.

[0003] European Patent 1630757 and Japanese Patent 2006092128 describe a mechanism to track stolen/lost articles with RFID tag. The defined tracking systems involve the use of multiple static or mobile RFID readers to locate the lost device. Once the device is located through the readers, a notification will be send to the device owner. Japanese Patent 2006092128 also depicts the use of camera functionality of mobile readers to help third party human agent to identify the lost stolen article. These technologies are considered to be of relevance with this invention because this invention also seeks to use the RFID technology in finding or locating lost devices.

[0004] Aspects of the invention are defined in the claims.

[0005] Some embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings.

[0006] We now describe a tracking and recovery mechanism for lost or misplaced mobile handheld devices. For the purposes of description, it will be assumed that the lost device is a cellphone, i.e. a portable telephone usable with a cellular radio network such as GSM, but it could equally well be a laptop computer, personal digital assistant (PDA), or other intelligent device such as perhaps a Wi-fi enabled MP3 player.

[0007] This recovery mechanism assumes that the lost device has a near field wireless link capability of the Radio Frequency Identification (RFID) type, but other near field wireless link communication technology such as Bluetooth or infra-red could also be used. We will describe implementations applicable when the lost device is in the power on and in the power off state although is not essential that all implementations of the invention incorporate both functionalities.

[0008] The outline diagram of the system in Figure 1 shows a lost device 1, in the form of a cellular telephone 1. The device 1 also has RFID capability as will be described in more detail below. Human agents who may be entrusted with the task of finding the lost device 1 are shown at 2, 2a, 2b. Each carries a mobile communication device 3, 3a, 3b, in this example also a cellular telephone, again with RFID capability. It is convenient, but not actually essential, that the agents' devices be of the same type as the lost device and/or as the devices of other agents; it is however essential that the near-field capability be the same as that of the lost device. More specifically, where a tag on the lost device is to be read, the agent's device should have reader functionality able to read the tag, and where a tag on the agent's device is to be read, the lost device should have reader functionality able to read that tag. The most convenient implementation is to make the lost device capable of acting as agent device and *vice versa*, so that the two have the same construction.

[0009] A server 4 has the function of liaising with the lost device and the agent devices; it can be a general purpose computer, suitably programmed, with an inter-

face to the cellular radio network 5 to which the lost device 1 and agent devices 3, 3a, 3b also belong, so that it may exchange messages with them.

[0010] This implementation of the invention makes use of the lost device's near field wireless link capability to identify a possible third party human agent upon the declaration of item lost by the owner if the lost device is on power on mode. Otherwise, server will locate a trusted potential agent on behalf of the lost device.

[0011] The system consists of several aspects as listed below:

1. Locating a close proximity agent using the lost device's near field wireless links
2. Locating a neighbouring proximity agent using the lost device's near field wireless links
3. Locating the lost device using RFID through trusted agents identified by the server.

[0012] Figure 1A is a block diagram of a cellular telephone, which can be the lost device 1 or the agent device 3. As well as the usual battery 100, transceiver 101 and input/output systems 102 each mobile handheld device is equipped with one or more near field wireless links interface such as a standard mobile RFID reader 103 and an embedded RFID tag 104. For the implementation of embodiment 3, a dedicated "RFID TAG to Mobile Devices Interface" module 105 is added to the standard RFID tag and a beeper circuit 106 is added to the handheld device as shown in Figure 1A. The main functionality of the additional interface is that when a special command is received by the tag, this is recognised and acted upon to draw power from the device's battery in order either to activate the synchronous beeping functionality of the lost device or to power up the device for the ringing of a customized ring tone through the lost device.

[0013] In this description, **close proximity** is defined as the location within the base station or access point where the server has found the lost device. **Neighbouring proximity** is referring to location within next base station or access point where the server has found the lost device.

[0014] Figure 2 shows the flow process of embodiment 1. Some of the messages that are sent during this process are shown in Figure 6. The process is initiated at Step 200 by the owner of the lost device 1 reporting its loss to the server 4. This can be by any convenient means: by telephone to a human operator who keys the information into the server, or directly, perhaps via an internet connection to the server. Either way, the server receives a message to the effect that the device is lost, together with an identifier. The identifier can be but not limited to telephone number of the lost device, IMEI or RFID tag number of the lost device. In the present example, of a lost phone, this is the telephone number. Once the mobile handheld device is reported lost by the

owner, the server 4 interrogates the network 5 at Step 201 to determine whether the respective device 1 is still connected to the network. If not, it is then (202) treated as a device that is in the "power off" state, as will be described later with reference to Figure 4.

[0015] Assuming that the lost device's location is detected, the server sends (203) a message via the network 5 to the lost device 1 to activate its RFID reader 103 if the reader is in off state in order to scan (204) for a legitimate agent. Preferably this message does not trigger ringing or any other audible or visual indication by the device. In this description we refer to such messages as "stealthy message". This requires only minor modification of the device's software to recognise and act upon the signal.

[0016] If no active agent is detected during this stage, control is passed (205, 206) to a neighbouring agent detection mechanism (refer to Figure 3 for more detailed description). If there is at least one agent within RFID range of the lost device, then the RFID tag on (for example) the agent device 2 transmits a response message that is then received by the RFID reader 103 of the lost device 1. This message contains a tag identifier. If two or more agent devices respond, then only the agent with strongest link is captured. If two or more agents have the same or similar signal strength then if desired these agents' information can be sent to the owner, who then decides which agent to choose at step 209, but other strategies for dealing with this situation could also be employed. Details of the agent device(s) not chosen could be held for later use.

[0017] Then, at Step 207, the lost device informs the server 4, via the network 5, of the tag information of the potential agent device. The server 4 validates the agent (e.g. by reference to a database held at the server containing tag information on authorised agents) to prevent connection to a bogus agent. Alternatively, or in addition, the server may contact the owner at 208, giving the credentials of the agent device and asking for confirmation that the owner agrees to use of this agent. If the validation or confirmation fails then the process returns via 209 to Step 204 to scan for another agent device (or choose the second agent in the proximity list).

[0018] Once the agent device is validated, the server sends at Step 209 a request to the agent device 2 to check whether the agent is willing to help in locating the lost device, and if not the process returns via 211 to 204. Upon the agent device sending a message of confirmation back to the server, the server sends (Step 212) a customized ring tone such as "John Thomson, Please pick me UP" to the lost device for the lost device to auto play the ring tone (Step 213) in order to attract the agent's attention.

[0019] This "auto play" requires modifications to the phone, in that software needs to be installed in order for the lost device to download or receive the customized ringtone and then play it automatically, and then automatically delete it. Alternatively, the custom ring tone

could be downloaded in conventional manner and then followed by an ordinary phone call from the server to the phone to cause it to ring. In the latter case, a further command needs to be sent afterwards in order to revert to the original ring tone.

[0020] Once the agent picks up the lost device, (215) the agent then needs to send a RFID command to the lost device to stop the ring tone and the credential of the agent is captured by the lost device and send back to server. This is done so as to provide non-repudiation protection to the lost device owner as the agent cannot deny picking up the lost device. A confirmation message coupled with the agent's RFID credentials is sent to the server by the agent for confirmation (216). The process is then complete.

[0021] The agent device needs to stop the customer ring tone by issuing a stop command through its RFID thus confirming that agent is picking up the lost device. This command is also used as a signature to confirm that the lost device has been picked up.

[0022] In the event that no trusted agent is found in close proximity, the server will served as a middle-man to locate another trusted agent that is in neighbouring proximity. The flow process of this implementation is illustrated in Figure 3.

[0023] 300: A lost device that is unable to find a potential trusted agent informs the server, and 301: the server searches for the trusted agent on behalf of the lost device. In order to perform this search, the server interrogates the network to determine which cell of the network the lost device is located in (or of course this information could be obtained at Step 201). Then the server sends, via the network 5, a message to one or more of its agents known to be within close or neighbouring proximity. With the aid of the HLR and VLR of the network, the server can determine the identity of the trusted agent(s) within close or neighbouring proximity.

[0024] Upon failing to locate an agent, at 301/302 the server sends a notification to the owner.

[0025] If an agent device is found, then if desired, the server may contact the owner at 303, giving the credentials of the agent and asking for confirmation that the owner agrees to use of this agent. If confirmation fails then the process returns via 304 to Step 301 to scan for another agent device.

[0026] Assuming all is well, a notification is sent (304A) to the agent device to ensure that the agent is willing to help in searching the lost device, and if not the process returns via 305 to 301 to look for another agent. Once the agent agrees to locate the lost device, then at 306 the server sends, to the agent device, the location information of the lost device, based on the identity of the base station serving the cell that the lost device is in. The agent device displays the information on a screen for the agent to read (for example it could be sent as a text message). Only location information is sent. The granularity or accuracy of the location information depends very much on the technology used by the mobile network.

[0027] At the same time, server sends via the network 5 (Steps 307, 308) the agent's near field wireless link interface credentials such as RFID tag information, and customized ring tone, to the lost device. The near field wireless link interface credentials are used (Step 309) by the RFID reader 103 of the lost device to scan for the agent device. Once the lost device identifies the agent device's RFID tag 104, the customized ring tone is played automatically to attract the agent's attention. Once the agent picks up the device by stopping the ring tone a confirmation message coupled with the agent's RFID credentials is sent to the server, as in the case of step 216, described above.

[0028] Figure 4 shows the steps to be taken when the lost device is in a "power off" state. Some of the messages that are sent during this process are shown in Figure 7. Once the lost device 1 is confirmed to be power off or disconnected from the network, the server 4 retrieves from the network 5 the last active information on the lost device to gauge the current location of the device (Step 400). In order to find the lost device, the server searches (402) for a potential close proximity agent; if it fails to do so, it searches (403) for a neighbouring proximity agent. The details of this kind of search have already been explained in relation to Step 301 of Figure 3. If an agent device is found, then at Step 404 a notification is sent to the respective agent. Once the agent has agreed (405) to participate in locating the lost device, the server sends (Step 406) the respective lost device's RFID tag information and location information to the agent device. Using the tag information sent by the server, the agent device uses its RFID reader to scan for the lost device (Step 407). If the lost device is found, a n-bit string command from the agent device will be sent to the lost device's RFID tag 104 to wake up the lost device (Step 410). If the lost device has sufficient reserved battery power, the n-bit string RFID command is used to auto power on the lost device (415). Once powered on, the device can communicate with the server to download customized ring tone to the lost device or doing other task such as back up. Thus the process continues with Steps 416 to 419 which are identical to steps 311, 314, 315 of Figure 3. If, at Step 411, the battery power of the particular device is deemed low, a minimum amount of power from the battery is drawn to power on the synchronous beeping circuits 106. The purpose of the beeping circuits is to help agent to identify the lost device.

[0029] Once the agent picks up the lost device by stopping the ring tone a confirmation message coupled with the agent's RFID credentials is sent to the server. For the synchronous beeping implementation, this occurs once the agent has stopped the beeping functionality (413). At 414, the agent's credentials are recorded in the lost device through RFID.

[0030] The synchronous beeping feature is realized through the exchanging of bit strings through RFID front ends between the lost device and the agent device. Special software/instruction code is added to the RFID TAG

to Mobile Devices Interface 105 and Synchronous Beep-er Circuits 106 in order to perform the synchronous beeping features. One possible sequence is as follows, where it is understood that each time a bitstring is sent, it is transmitted by the RFID reader 103 of the one device to the RFID tag 104 of the other device, and the interface 105 passes an appropriate instruction to the beeper circuits 106.

1. Agent device send n bits to wake up lost device; 10
2. Lost device wakes up, beeps once. Lost device sends the corresponding beeping bit string to agent to execute the same number of beeps; 15
3. On receiving the bit string instruction from the lost device, the agent device beeps once. The agent device then triggers a new self beep sequence which is the number of previous beeping plus 1 new beep; next, the agent device sends the corresponding beeping bit string to the lost device. 20
4. On receiving the bit string instruction from the agent device, the lost device beeps twice. The lost device then triggers a new self beep sequence which is the number of previous beeping plus 1 new beep; next, the lost devices sends the corresponding beeping bit string to the agent device. 25
5. Steps 3 and 4 repeat until process ends. 30

Resulting in the following sequence:

[0031] Lost device beeps once, agent device responds by beeping once 35

[0032] Agent device beeps twice, lost device beeps twice in response to the agent's beeping.

[0033] The sequence continues until terminated by Step 313, Figure 4. It will be understood that previous tracking technologies for mobile handheld devices required the devices to be power on before the tracking can take place. When the lost device is on power on mode, the systems we have described involve the use of the lost device's near field wireless link such as an RFID reader to identify a trusted human agent in the vicinity. This implementation can greatly reduce security or privacy concerns as this implementation does not need to broadcast the lost items tag information to a large number of mobile RFID readers around the vicinity. The lost device has control over which third party human agent to choose in locating itself. The tracking and seeking mechanism can start immediately after the authorized user reports loss of the device to the server, thus speeding the time to locate devices that are being switched off deliberately or because of running low of battery. It will be noted that, as described, the system also prevents the lost device from producing any audio alerts before a trusted human agent is identified. 50 55

Claims

1. A method of locating a lost portable communication device (1) with the aid of a second portable device (2), wherein 5
the lost portable communication device (1) has a first, relatively long range, transceiver (101) for user communication and a second, relatively short range transceiver (103) operable to scan for a tagged second portable device (2) in the vicinity; the method comprising
(a) transmitting (203) a command from a remote station (4) to the first transceiver (101) of the lost device (1);
(b) upon receipt of the command at the lost device, triggering scanning (204) by the second transceiver (103);
(c) following the identification of a tagged second portable communication device (2), sending (210) to the second portable device (2) a request for a user thereof to search for the lost communication device. 10
2. A method according to claim 1 in which first transceiver acts upon the command without generating any audible or visible indication. 15
3. A method according to claim 1 or 2 in which the second portable device (2) also has a relatively long range transceiver and following the identification of a tagged second portable communication device (2) the lost device sends (207) from its first transceiver a message to the remote station which then sends (210) to the relatively long range transceiver of the second portable device (2) the request for a user thereof to search for the lost communication device. 20 25
4. A method according to claim 3 in which the remote station, upon receipt of the message, also sends (212) to the first transceiver (101) of the lost portable communication device (1) a customised encoded audio signal which the lost portable communication device (1) then plays (213) as an audible indication for the user of the second portable communication device. 30 35
5. A method according to any one of claims 1 to 4 in which the second portable device (2) also has a relatively long range transceiver and in which, in the event that the scanning of step (b) fails to find a second portable device:
(i) the first transceiver of the lost device (1) notifies (300) the remote station (4);
(ii) the remote station (4) transmits (301) at least one invitation to which the relatively long range transceiver of a second portable device (2) may 40 45 50 55

- respond;
- (iii) upon receiving such a response, the remote station (4) sends to the relatively long range transceiver of the second portable device (2) a request for a user thereof to search for the lost communication device (1) and (306) information as to the location of the lost communication device (1).
6. A method according to claim 5 in which the relatively long range transceivers are transceivers of a cellular radio network (5) and the remote station (4) determines, from the network, said information as to the location of the lost communication device.
7. A method according to claim 5 or 6 in which the relatively long range transceivers are transceivers of a cellular radio network (5) and the remote station (4) uses information from the network as to the location of the lost communication device and of second portable devices to determine the identity of second portable devices to which it is to send an invitation in step (ii).
8. A portable communication device comprising:
- a first, relatively long range, transceiver for user communication;
 - a second, relatively short range transceiver operable to scan for a tagged device in the vicinity; control means operable upon receipt by the first transceiver of a command from a remote station to trigger scanning by the second transceiver.
9. A method of locating a lost portable communication device (1) with the aid of a second portable device (2), wherein
- the lost portable communication device (1) has a first, relatively long range, transceiver (101) for user communication and a second, relatively short range tag transceiver (104) operable to respond to interrogation signals from a scanning device (2) in the vicinity;
 - the second portable communication device (2) has a first, relatively long range, transceiver (101) for user communication and a second, relatively short range transceiver (103) operable to scan for a tagged portable device (1) in the vicinity; the method comprising
 - (a) transmitting (406) a command from a remote station (4) to the first transceiver (101) of the second device (1), said command containing data identifying the lost device;
 - (b) upon receipt of the command at the second device, triggering scanning (407) by the second transceiver (103) for a device
- matching the identifying data;
- (c) following the identification of a matching tagged portable communication device (1), sending (410) to the tag transceiver of the matching portable device (1) a command to switch the first transceiver of the device from a power-off state to a power-on state.
10. A method according to claim 9 in which the remote station sends (416) to the powered-on first transceiver (101) of the lost portable communication device (1) a customised encoded audio signal which the lost portable communication device (1) then plays (417) as an audible indication for the user of the second portable communication device.
11. A method according to claim 9 or 10 in which, in the event that the first transceiver of the matching portable device cannot assume a power-on state owing to insufficient power, an auxiliary warning device in the matching portable device is actuated.
12. A method according to claim 11 in which the auxiliary warning device cooperates with an auxiliary warning device of the second portable device in a procedure in which one auxiliary device generates an audible warning and sends to the other auxiliary warning device a command to generate a like audible warning.
13. A method according to claim 12 in which further pairs of like audible warnings, each different from the preceding pair, are generated.
14. A portable communication device comprising:
- a first, relatively long range, transceiver for user communication;
 - a relatively short range tag transceiver operable to respond to interrogation signals from a scanning device in the vicinity;
 - control means operable upon receipt by the tag transceiver of a command from a device in the vicinity to switch the first transceiver from a power-off state to a power-on state.

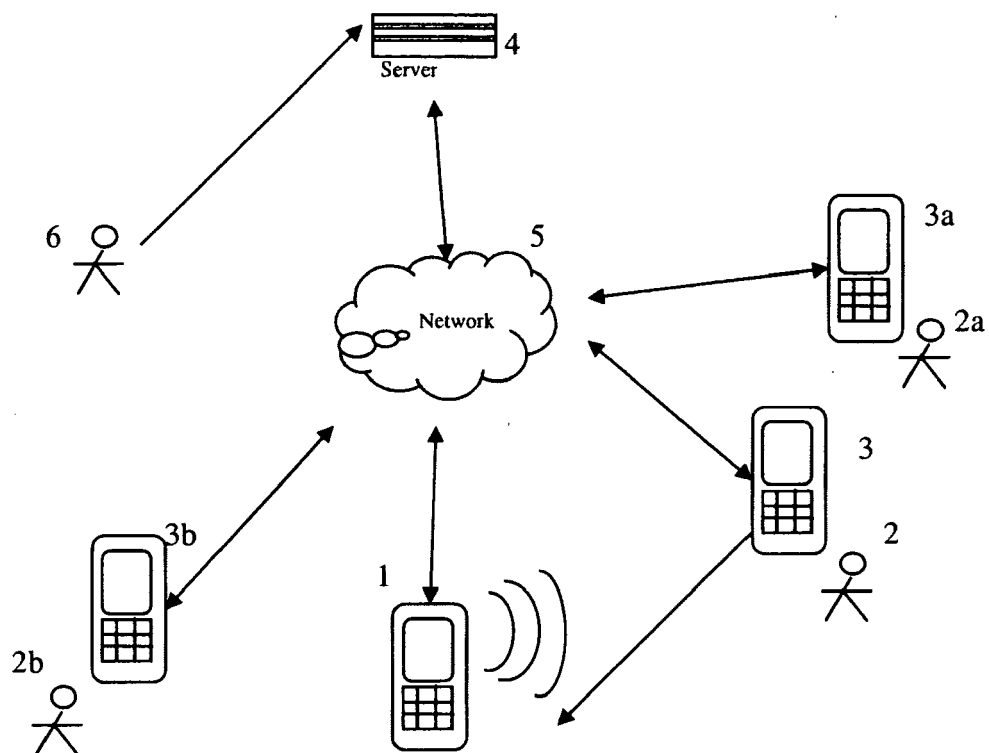


Figure 1

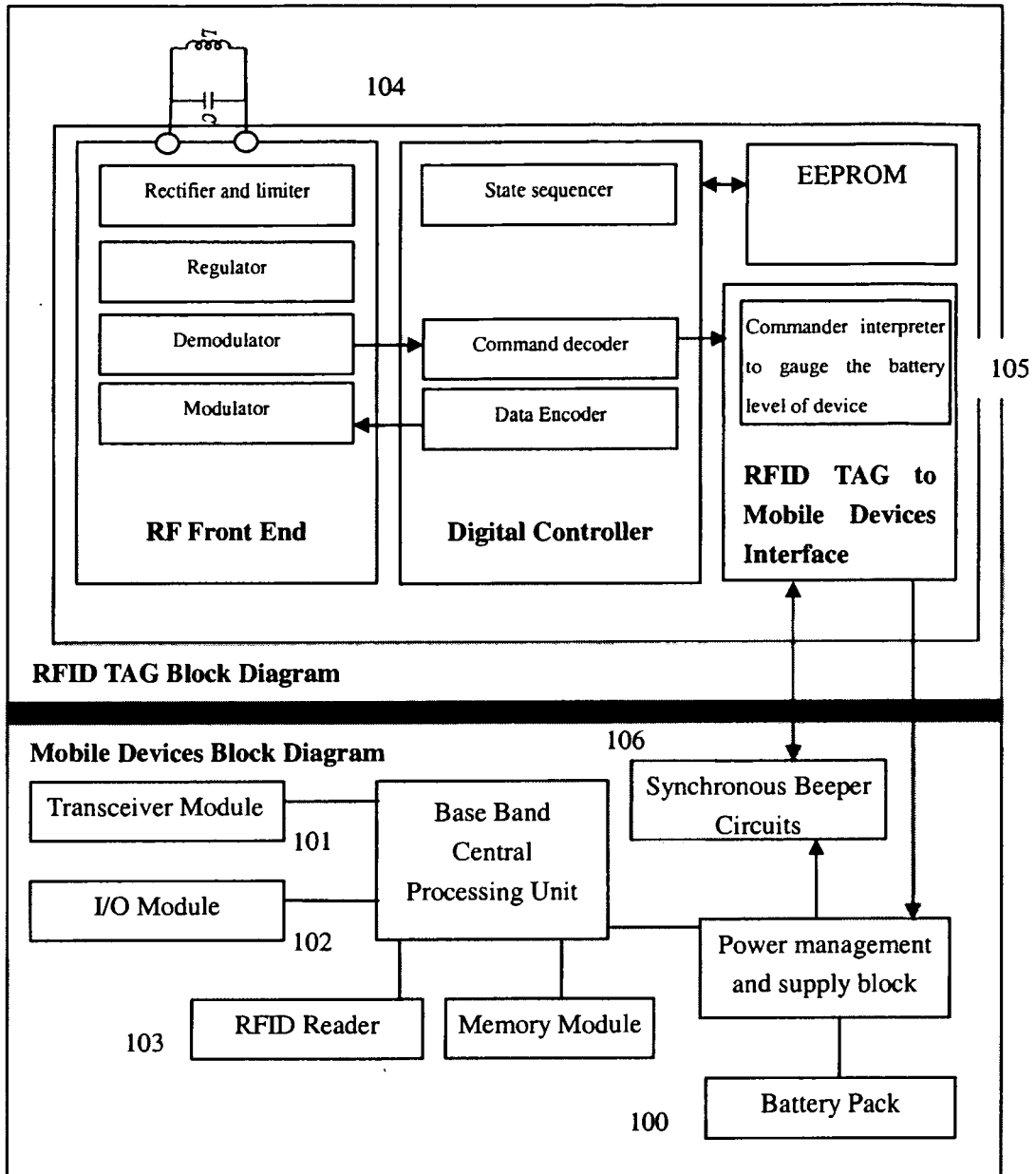


Figure 1A

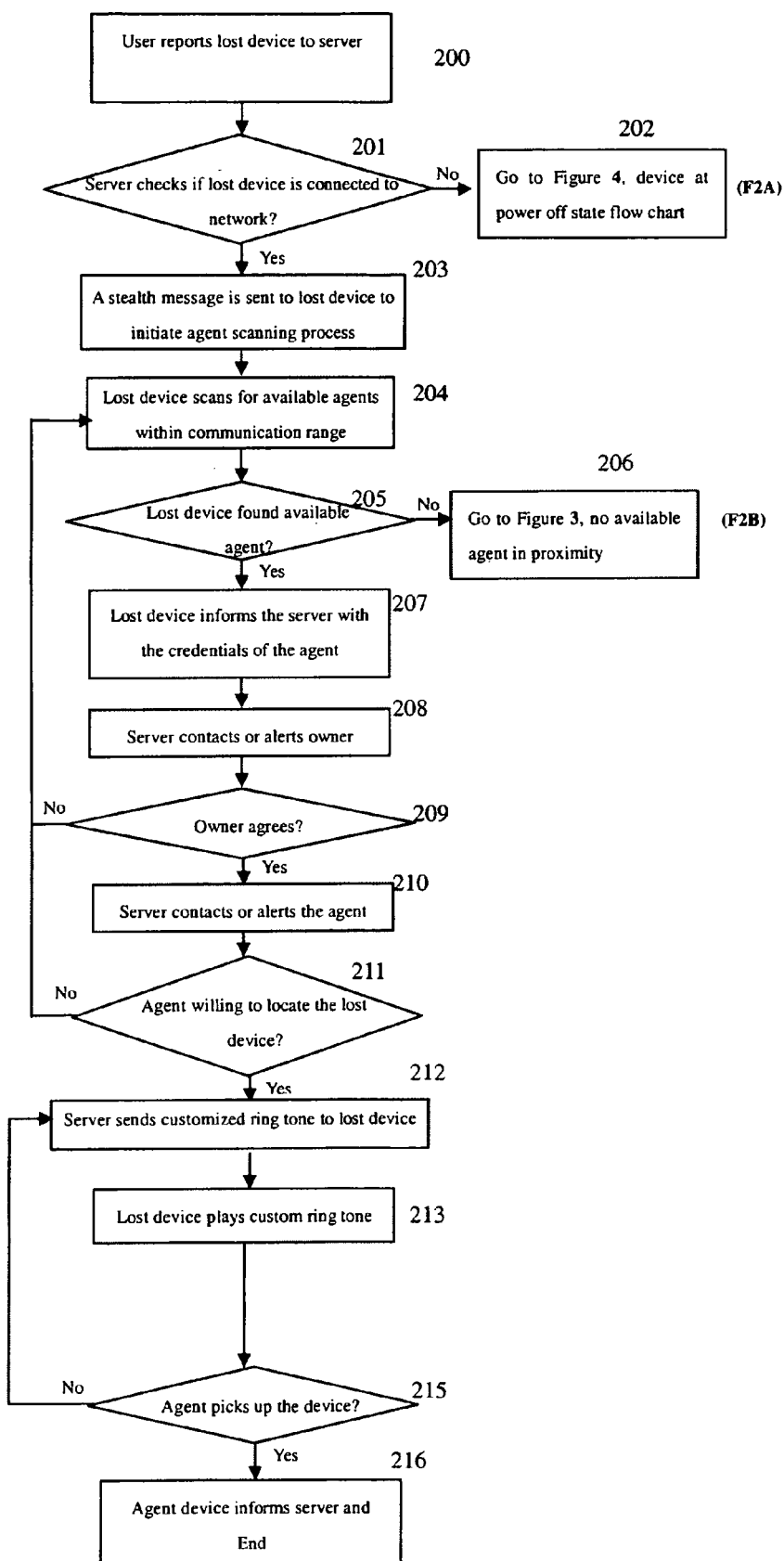


Figure 2

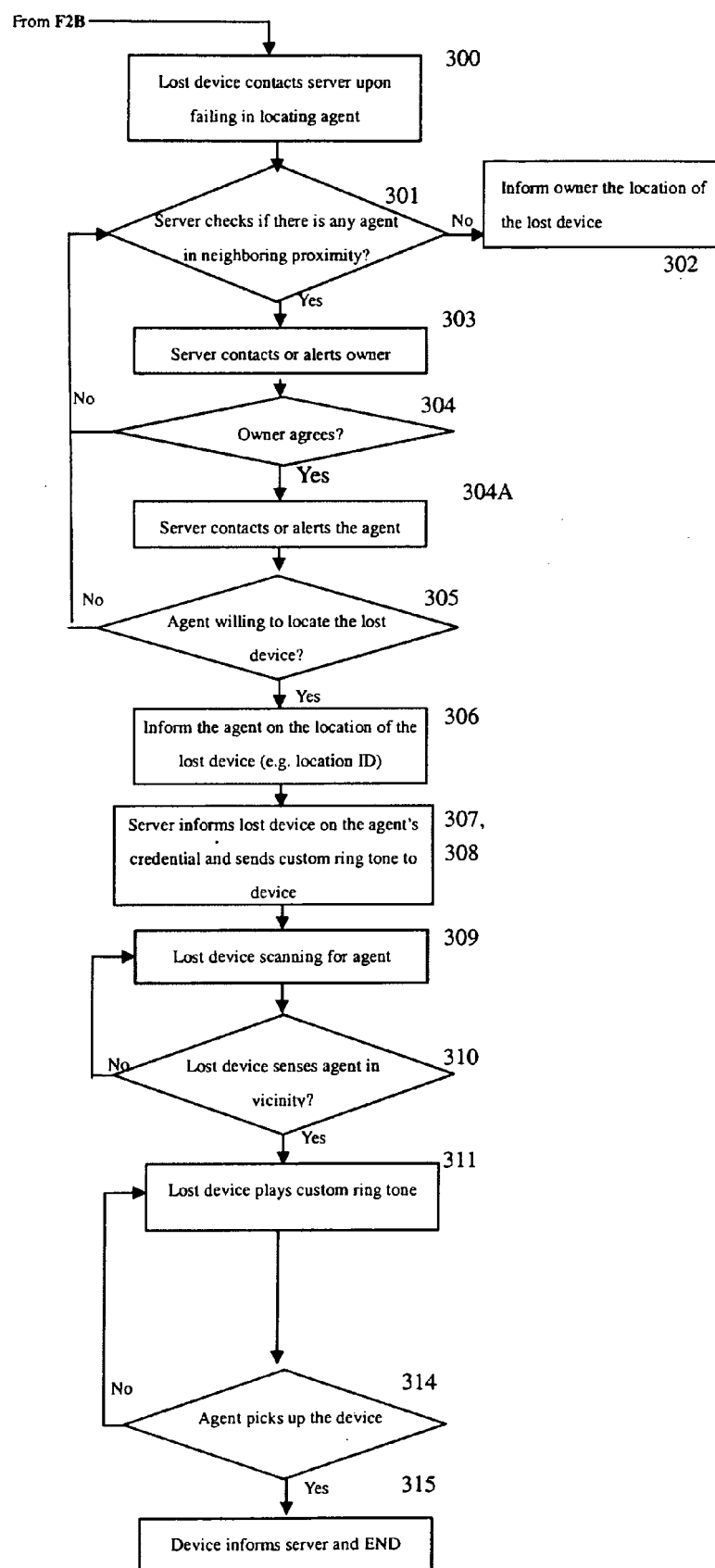


Figure 3

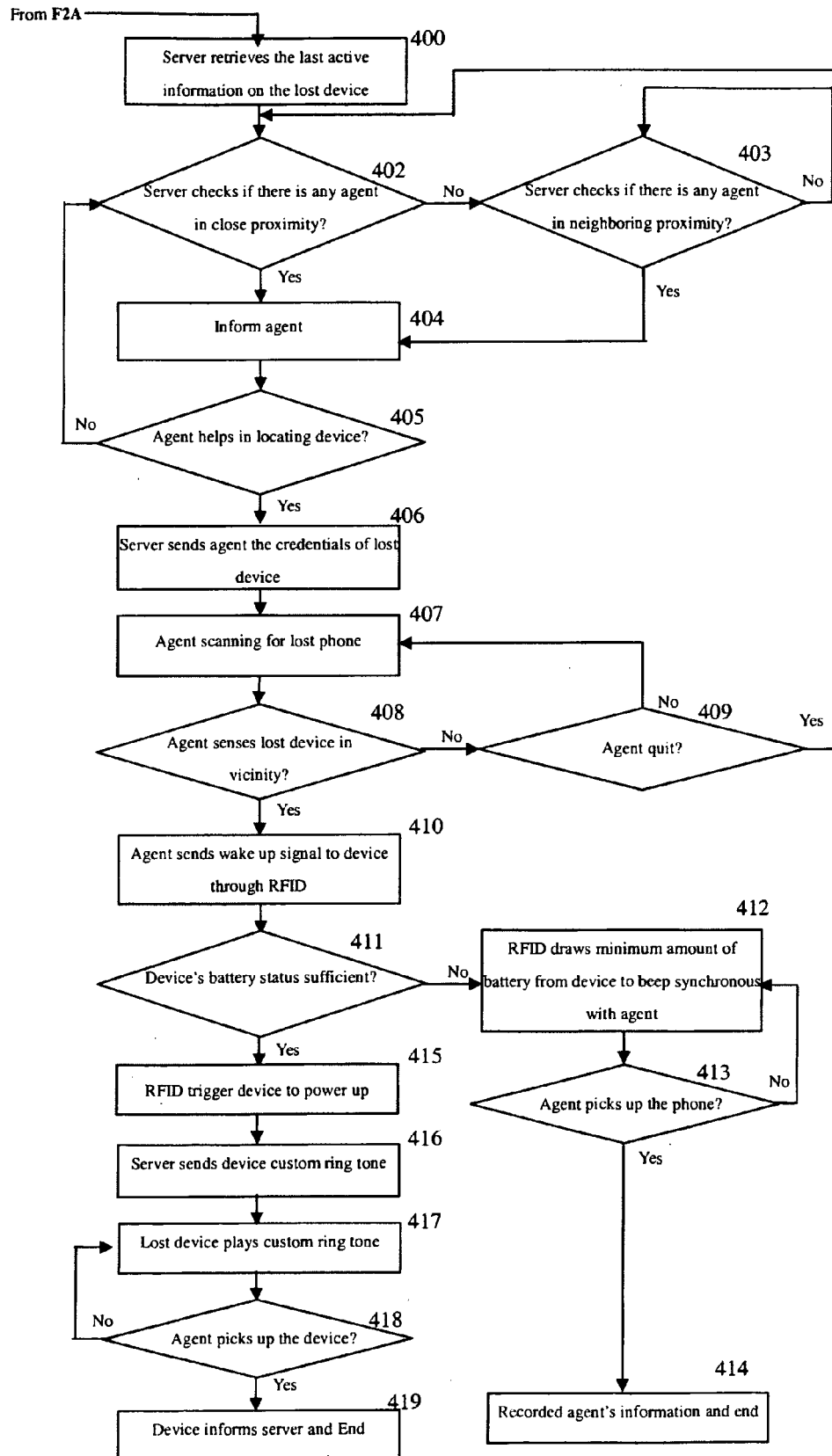
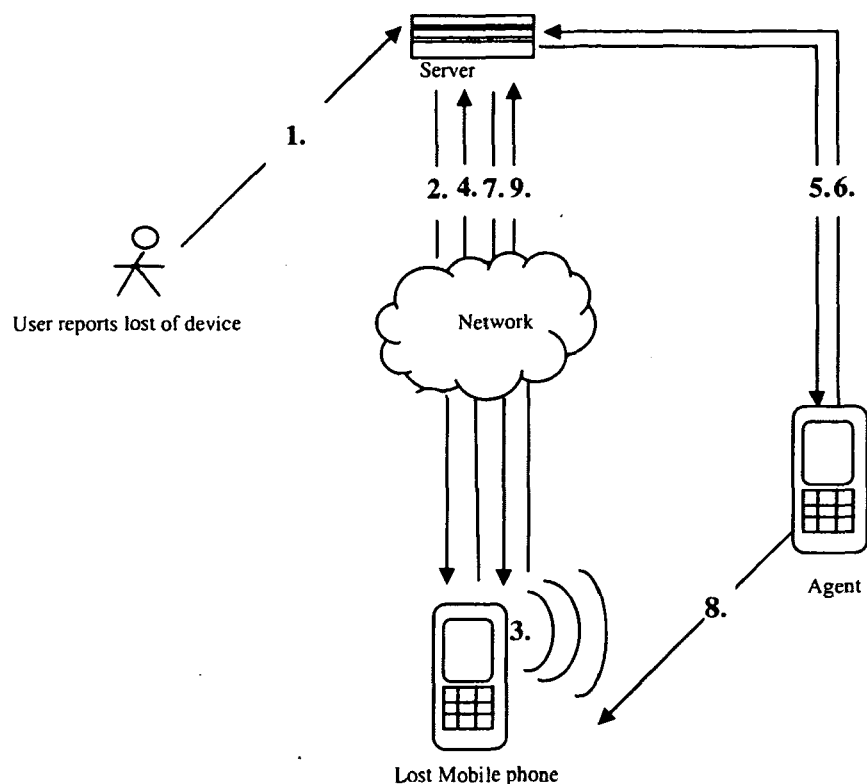


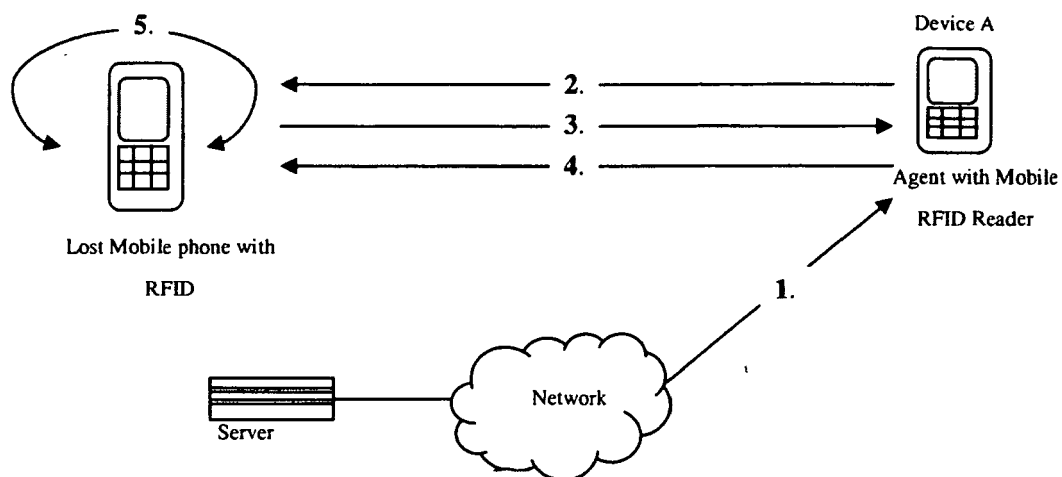
Figure 4



Notes*

1. User inform server on lost of device
2. Server determine if lost device is power on or power off
3. If power on server trigger the near filed wireless interface of lost device to automatically search for trusted agent
4. Upon finding trusted agent, the credential of the agent is sent to server for verification
5. Server validates the identity of agent and sends a request to agent
6. Agent accepts the request
7. Server sends custom ring tone and triggers the lost device to automatically playing the particular ring tone
8. Agent identify the lost device through custom ring tone
9. Confirmation is sent to server

Figure 5



Notes*

1. Server sends the lost device's RFID Tag information to Mobile RFID readers A
2. Mobile RFID readers A scanning for RFID Tag with the corresponding information sent by server.
3. Lost device's RFID Tag response to Mobile RFID reader's interrogation.
4. A command is sent to the lost device's RFID Tag to draw battery from device to either power on the device or activated synchronous beeper
5. The RFID tag decodes the command according to the device battery's power level.

Figure 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 25 4191

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Place of search Munich		Date of completion of the search 10 April 2008	Examiner La Gioia, Cosimo
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

3
EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 25 4191

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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